



Docket No.: M4065.0133/P133  
(PATENT)

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Patent Application of:  
Brian A. Vaartstra, et al.

Application No.: 09/268,326

Group Art Unit: 2811

Filed: March 16, 1999

Examiner: C. Nguyen

For: MIXED METAL NITRIDE AND BORIDE  
BARRIER LAYERS

Assistant Commissioner for Patents  
Washington, D.C. 20231

**DECLARATION OF DONALD L. WESTMORELAND UNDER 37 CFR 1.131**

I Donald L. Westmoreland declare and state as follows:

1. I reside at 10258 Alliance Street, Boise, Idaho 83704.
2. I am one of the two named inventors of the above-identified U.S. patent application (the "326 application"), filed on March 16, 1999, as evidenced by the attached executed Declaration and Power of Attorney filed with the application (Exhibit 1).
3. I have reviewed and understand the '326 application, including the currently pending claims (the "Claimed Inventions").
4. Brian Vaartstra and myself conceived of the invention covered by the Claimed Inventions prior to June 30, 1997, as evidenced by Exhibit 2, which is a Micron Technology Inc. Patent Committee Proposal Document (the "Proposal"). The actual date of this submission has been blanked out, as has any description not relevant to the conception of the Claimed Inventions. Micron Technology Inc. is the assignee of the present application, as shown in the Assignment attached as Exhibit 1. Attached to the

Serial No.: 09/268,326

Docket No. M4065.0133/P133

Proposal is a copy of engineering notes drafted prior to June 30, 1997, describing and illustrating the Claimed Inventions. The Proposal and engineering notes indicate a date of conception (blanked out) of the Claimed Inventions prior to June 30, 1997.

5. After the approval of the Proposal by Micron Technology, Inc.'s Patent Committee the law firm of Dickstein Shapiro Morin & Oshinsky LLP ("DSMO") began preparation of drafts of the present application covering the Claimed Inventions. Attached as Exhibit 3 is a letter written by a DSMO attorney forwarding a final draft of the present application covering the Claimed Inventions, along with Declaration and Assignment forms, to Micron Technology, Inc. The date on this letter has been blanked-out.

6. The present application covering the Claimed Inventions was executed by Brian Vaartstra and myself on February 17, 1999, as evidenced by the Declaration and Power of Attorney attached as Exhibit 1. The present application was filed with the United States Patent and Trademark Office on March 16, 1999. The preparation of the present application covering the Claimed Inventions was diligently pursued from the conception date (prior to June 30, 1997) to the date of filing (March 16, 1999) of the present application.

All statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true; and these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful and false statements may jeopardize the validity of the above-identified patent.

Date: April 19, 2001

By: Donald L. Westmoreland

Donald L. Westmoreland

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If ARPA project,  
please check below:

## INVENTION DISCLOSURE

- ☐ Advanced SRAM  
☐ BST  
☐ FED  
☐ FE RAM  
☐ NCAICM

1. INVENTOR(S): Brian A. Vaartstra and Don Westmoreland

## 2. DESCRIPTION

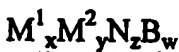
## 2.1 Title of invention:

**Mixed-metal Nitrides and Borides as Barriers Layers**

## 2.2 Brief description:

There is currently a great deal of interest in barriers for oxide dielectrics such as  $Ta_2O_5$  and  $(Ba,Sr)TiO_3$ . These high K materials require deposition on electrodes or barriers that are extremely resistant to oxidation and silicidation. Although metal borides and nitrides have been investigated to some degree, they tend to be polycrystalline. It has been suggested that barriers that are amorphous may be advantageous, so that there are no grain boundaries to aid diffusion of atomic species. Ternary compounds, for example, like  $Ta_xN_ySi_z$  are amorphous and appear to be better barriers than TiN for copper contacts. Likewise, it is known that TiAlN is better than TiN as a barrier to oxidation because of the oxidation resistance of AlN. Therefore it is of interest to use mixed metal nitrides, borides or boride-nitrides as barriers. Early transition metal borides and nitrides are all rather conductive and thus the mixed metal systems and mixed boride-nitride systems would be conductive and potentially amorphous.

This application proposes we seek patent protection on the compositions of general formula:



where  $M^1$  can be Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W.  $M^2$  is Al.

x and y are subscripts denoting the stoichiometry of the two metals ( $x > 0$ ,  $y = 0$  or  $> 0$ ).

z and w are subscripts denoting the nitrogen and boron stoichiometries, respectively ( $z + w > 0$ ).

For  $y = 0$ , z and w both  $> 0$ . For  $M = Ti$ ,  $w \neq 0$

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2.3 Also attach a complete description, including drawings or sketches and articles relevant to the invention. Legible photocopies of laboratory notebooks are acceptable.

Copy of lab notebook pages BV001-134 and -135 attached.

### 3. INFORMATION CONCERNING CONCEPTION OF INVENTION

#### 3.1 CONCEPTION AND DOCUMENTATION OF THE INVENTION

a. Identify the date when you first conceived the invention. (If not sure, give the earliest date of which you are sure.)

[REDACTED]

b. To whom was the idea first described and on what date? (Other than a co-inventor.)

Brenda D. Wanner on [REDACTED]

c. Identify the date of the first tangible record such as computer simulation, tape out, drawing or written description. Please specify type and location.

[REDACTED] in Lab book number BV-001 pages 134,135 (copy attached)

#### 3.2 CONCEPTION OF THE INVENTION

a. Please identify related invention disclosures, patents or other publications describing similar ideas, and other companies working in the same field. Attach copies, if available.

[REDACTED]

[REDACTED]

b. What is the closest technology, of which you are aware?

[REDACTED]

c. Identify the advantages of this invention over previous technology.

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This invention proposes a larger class of compounds than TiAlN, and includes ternary metal nitride-borides and ternary metal borides. As the requirements on barriers become more stringent, there is a need to look at more complex materials to ensure low resistivity and low reactivity with oxides, oxygen and silicon.

### 3.3 IMPORTANT DATES

a. Has the invention been disclosed outside the company? no  
If yes, to whom, when, and in what form?

b. Have any articles describing your invention been published? no  
If yes, list author(s), title of article, publication and date.

c. Have any engineering samples been given out? N/A  
If yes, to whom and on what date?

d. Has any product using the invention been sold or offered for sale? no  
If yes, to whom and on what date?

### 3.4 DISPOSITION OF THE INVENTION

a. When will (or did) Micron begin use of the invention experimentally?  
unknown

b. When will (or did) Micron begin production of this invention?  
unknown

### 3.5 MISCELLANEOUS INFORMATION

a. Was the invention developed during a joint development agreement or other contract with an outside company? no

b. Please list developmental work outside of the company (including Government proposal or contract).

This invention was not developed outside of the company in any way.

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4. INVENTORS:

1. Name: Brian A. Vaartstra

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Company Name(VERY IMPORTANT): Dept. Name: Micron Synthesis Lab

☒ Micron Technology, Inc. Dept. #: 857

☐ Micron Computer, Inc.

☐ Micron Custom Manufacturing Services, Inc.

☐ Micron Display Technology, Inc.

☐ Micron Communications, Inc.

☐ Other \_\_\_\_\_

Home Address: 3417 Braden Lane

Nampa, ID 83686

Citizenship: Canada

Supervisor: Don Westmoreland

Signature: \_\_\_\_\_

Date: 

2. Name: Donald Westmoreland

Micron Phone: 83315 Micron Mail Stop: 632

Company Name(VERY IMPORTANT): Dept. Name: Micron Synthesis Lab

☒ Micron Technology, Inc. Dept. #: 857

☐ Micron Computer, Inc.

☐ Micron Custom Manufacturing Services, Inc.

☐ Micron Display Technology, Inc.

☐ Micron Communications, Inc.

☐ Other \_\_\_\_\_


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Boise, ID 83704

Citizenship: U.S.A.


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Supervisor: Trung Doan

Signature: Donald L. Westcott Date: 

#### 5. WITNESS

If there is only one inventor, a witness should sign and date this disclosure. A witness in this case is a non-inventor who understands the nature of the invention.

Stefan Kienhub   
(Signature of Witness) (Date)

Note: If you have any questions or wish assistance completing this form, please call the Legal/Patent Department, ext. 4527.

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# $Ta_2Al_3N_2$ as diffusion barrier

It is proposed that  $Ta_2Al_3N_2$  would be a useful material for diffusion barriers where metals are to be prevented from combining with silicon. It may also be effective in prevent high dielectric oxides from reacting with under silicon or other electrical material. Ta is especially interesting since it is a refractory metal that does not form copper compounds. Further AlN is resistant to oxidation by high dielectrics such as  $Ta_2O_5$  or  $SrTiO_3$ , or  $(Ba, Sr)TiO_3$ . The  $Ta_2Al_3N_2$  layer may further have a Ta metal layer beneath it to form a good contact with silicon or other underlying electrical.

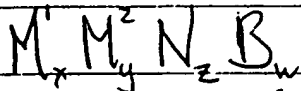
B. H. Kautler

Read & Understood by: Brenda D. Warner



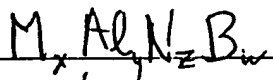
# Mixed-Metal Nitrides & Borides as Barriers

It is further proposed that various metal nitrides and borides of the following general formulae would be useful as barriers to either metallizations or high dielectric constant materials:



where  $M'$  and  $M''$  can be eg. Ti, Al, Ta, Al, or  $M'$  and  $M''$  can be (Ti, Zr, Hf, V, Nb, Ta, Mo, W) for  $M'$  and Al for  $M''$

ie.



where M is

the above chosen metals, and  $x, y, z$  and  $w$  are subscripts denoting the stoichiometry of each element in the material -  $x, y > 0$ ;  $z, w$  may be zero, but not both zero.

*[Signature]*

Read and understood by: Brenda D Wanner